

## CRATE FOR CONTAINERS

## CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority under 35 U.S.C. 119 from U.S. Patent Application Serial Number 10/458149 filed on June 10, 2003.

## BACKGROUND OF THE INVENTION

The invention relates to crates suitable for holding a plurality of containers like bottles. Such crates are generally known and are presently mainly made out of thermoplastic materials like polyolefin's. The crates are used for the transport of containers and are often also used to display containers filled with beverages like beer and sodas in retail outlets. To make them look more attractive they are often made out of coloured plastic materials. They are sometimes printed with trademarks and fancy designs to promote sales of the containers and their content. The crates should be strong enough so they can be reused over many years. It is further required in many cases that they withstand cleaning agents so that they can be cleaned before being reused. Since the crates are usually stacked one upon another creep resistance is another important property. It is often required that the crates do not crack when they are dropped from a height of 2.5 meters or less.

It is also known to make crates out of two or more different materials. Part of one or more sidewalls of such crates may consist of a transparent material like polycarbonate and the bottom part and part of the sidewalls may consist of a non-transparent polyolefine.

In view of the above requirements there are few materials for the manufacture of crates that meet all requirements for the manufacture of crates.

## SUMMARY OF THE INVENTION

The invention provides for crates made out completely or partly of a transparent or translucent plastic material. In another embodiment the invention provides for crates made out of a transparent or translucent material absorbing UV radiation and part of the visible light.

The crates of the invention are made out of thermoplastic material being a transparent or translucent material comprising a blend of at least one thermoplastic

polycarbonate resin (PC) and at least one thermoplastic polyester resin (PE) comprising units derivable from a cycloaliphatic diol and a cycloaliphatic or aromatic diacid.

Several types of polyesters may be used with polycarbonates, such as BPA-based polycarbonates, to give the compositions and articles of this invention. Suitable polyester molecules comprise units derived from a cycloaliphatic diol and aromatic diacid compounds, specifically phthalic acid (specially terephthalic acid) (PCT). It is further possible to use polyesters comprising besides the units derived from a cycloaliphatic also some units derived from aliphatic diols (PCTG). It is also possible to use polyesters with two cyclic units like polycyclohexane dimethanol cyclohexane dicarboxylate (PCCD).

In addition, the polyester and polycarbonate can be blended with certain impact modifiers (IM) at such ratios as to match the refractive index (RI) of the impact modifier to that of the PC/PE blend and so still retain transparency. In addition to the characteristics of PC/PE blends, these PC/PE/IM blends possess improved low temperature ductility.

In another embodiment of the invention the crate is made out of a material comprising 20-90, more preferably 45-80 % by weight of the polycarbonate resin and 80-10, more preferably 55-20 % by weight of the polyester. The relative quantities are calculated with respect to the sum of the polycarbonate(s) and polyester(s) in the material.

In a further embodiment the polyester is polyester comprising units derivable from a cyclohexane diol and units derivable from one or more of iso- and terephthalic acid.

In a further embodiment the polyester comprises as diol component a mixture of 50-100 mol % of units derivable from a cycloaliphatic diol and 0-50 mol % units derivable from an alkylene glycol and as a diacid component 0-100 mol % units derivable from a phthalic acid and 100-0 mol % units derivable from a non-aromatic diacid.

In a further embodiment the crate of the invention has sidewalls transmitting at their most transparent spot more than 50% of a perpendicular incident ray of visible light.

In another embodiment the crate is made out of a thermoplastic material further comprising a dye and/or UV absorbers and has side walls with a thickness so that the side walls of the crate do not transmit more than 10 % or even not more than 5 % of incident radiation with a wavelength of 200 to 460 nanometer.

## DETAILED DESCRIPTION OF THE INVENTION

The crates of the invention can be of any shape and size. They usually have the shape of a box. They can hold any number of containers like bottles. A representative example of a crate is shown in Figure 1.

Transparency for UV radiation and the visible light region of 400-800 nm has been shown for some suitable materials of the example in figures 2 and 3.

Figure 1 shows a representative example of a crate according to the invention. The represented crate has the shape of a box. The represented crate serves only to give an indication a possible shape of a crate; the drawing has been made as if the crate were not transparent or translucent. The crate 1 is provided with sidewalls 2. In figure 1 the represented crate has four sidewalls. Inside the crate are provided separation walls 3, thus creating separated spaces 4 for holding containers like bottles. The number of separation walls and therefore the number of spaces 4 can vary widely. Usually the spaces 4 are adapted to the size of the containers. It is possible to have spaces for holding more than one container. The height of the separating walls sidewalls can vary. In the represented crate of figure 1 the sidewalls have been provided with reinforcing ribs. It is possible to use a different figuration of ribs or not to use ribs at all for example by increasing the thickness of the sidewalls.

In another embodiment (not shown) of the crates of the invention part of or the complete sidewalls have been made out of the transparent or translucent material as defined in the claims of this patent application. It is of course possible to make only one or just two or three of the side walls out of the transparent or translucent material.

The crate of the invention has been made partly or completely out of a transparent or translucent thermoplastic material. There are many known transparent or translucent thermoplastic materials. Only very few of those transparent materials are suitable for making the crates of the invention. The crates of the invention have been made out of a transparent or translucent thermoplastic material comprising a blend of at least one thermoplastic aromatic polycarbonate resin (PC) and at least one thermoplastic polyester resin comprising units derivable from a cycloaliphatic diol and a cycloaliphatic or an aromatic diacid. With this material it is possible to make crates with an attractive appearance due to their transparency or translucency, which are sufficiently strong and which can withstand usual washing operations with alkali solutions. The crates have sufficient resistance to creep and if made in accordance with common designs can with stand a drop test of up to 2,5 meters without

breakage or cracks. Above the crates can be easily made with traditional moulding equipment thanks to the good flow behaviour of the selected thermoplastic material.

The crates of the invention can be manufactured by known moulding processes like injection moulding. In case the crate is made out of two or more different materials, the best way for manufacturing consists of moulding of different parts of each of the selected materials and to assemble the different parts together.

Above-mentioned thermoplastic materials are commercially available. The used PC and the PE are also commercially available materials.

A suitable material will be a blend where the polyester has both cycloaromatic diacid and a mixture of cycloaliphatic and aliphatic diol components such as PCTG. The polycarbonate may be composed of units of BPA, SBI bisphenol, aryl substituted bisphenols, cycloaliphatic bisphenols and mixtures thereof. It is contemplated that acidic phosphorus based stabilizers are useful to retard melt reaction of the cycloaliphatic polyester and polycarbonate resin and improve colour.

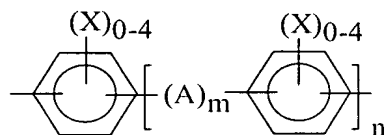
The ratio of polycarbonate to polyester can vary between 20:80 to 90:10 by weight. Blends from 50:50 to 80:20 are also suitable. Less than 80 weight percent polyester is desirable for a lower heat deflection. The presence of the polyester results in enhanced chemical resistance and enhanced UV resistance as compared to a base polymeric consisting entirely of polycarbonate. The resulting blend desirably has a glass transition temperature of from about 90 to 150°C. and a transmittance for visible light of greater than or equal to 50%. Desirable impact modifiers that may be incorporated in the blend have properties that do not affect the desirable transparency properties and have a refractive index (RI) between 1.51 and 1.58. Other desirable properties include a chemical resistance of the polyester and polycarbonate resin between about one and about 4 percent with Critical Stain as measured with Bergen Jig versus Coppertone, oleic acid and xylene. Preferably the MVR is 300 degrees Centigrade/1.2 kg between 35 and 60 (ml/10 min.), with a Flexural Modulus between 2200 and 1400 Mpa, and an HDTAe between 115 and 70 degrees Centigrade.

#### POLYCARBONATE

Aromatic polycarbonates are polymers or copolymers comprising carbonate linkages and units derivable from one or more aromatic dihydroxy compounds. Polycarbonates comprising also ester linkages can be used as well. The polycarbonate can also contain

siloxane units. It is possible to use materials comprising two or more polycarbonates, which may differ with respect to their molecular weight or with respect to their molecular structure or with respect to both mentioned properties.

Polycarbonates useful in the invention comprise the divalent residue of dihydric phenols, Ar', bonded through a carbonate linkage and are preferably represented by the general formula:



wherein A is a divalent hydrocarbon radical containing from 1 to about 15 carbon atoms or a substituted divalent hydrocarbon radical containing from 1 to about 15 carbon atoms; each X is independently selected from the group consisting of hydrogen, halogen, and a monovalent hydrocarbon radical such as an alkyl group of from 1 to about 8 carbon atoms, an aryl group of from 6 to about 18 carbon atoms, an arylalkyl group of from 7 to about 14 carbon atoms, an alkoxy group of from 1 to about 8 carbon atoms; and m is 0 or 1 and n is an integer of from 0 to about 5. Ar' may be a single aromatic ring like hydroquinone or resorcinol, or a multiple aromatic ring like biphenol or bisphenol A.

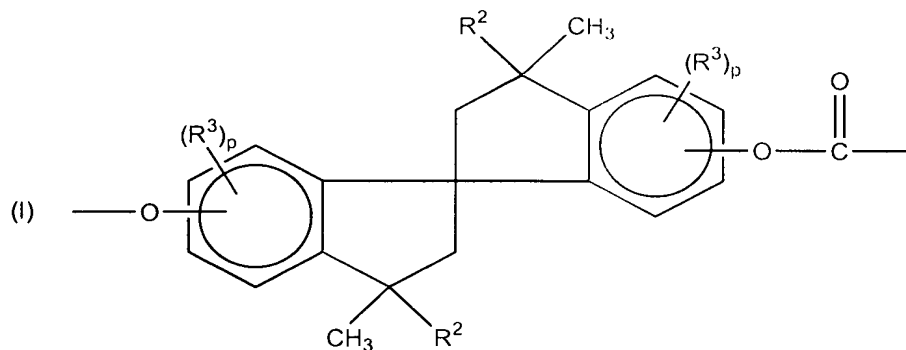
The dihydric phenols employed are known, and the reactive groups are thought to be the phenolic hydroxyl groups. Typical of some of the dihydric phenols employed are bisphenols such as bis(4-hydroxyphenyl)methane, 2,2-bis(4-hydroxyphenyl)propane (also known as bisphenol-A), 2,2-bis(4-hydroxy-3,5-dibromo-phenyl)propane; dihydric phenol ethers such as bis(4-hydroxyphenyl)ether, bis(3,5-dichloro-4-hydroxyphenyl)ether; p,p'-dihydroxydiphenyl and 3,3'-dichloro-4,4'-dihydroxydiphenyl; dihydroxyaryl sulfones such as bis(4-hydroxyphenyl)sulfone, bis(3,5-dimethyl-4-hydroxyphenyl)sulfone, dihydroxy benzenes such as resorcinol, hydroquinone, halo- and alkyl-substituted dihydroxybenzenes such as 1,4-dihydroxy-2,5-dichlorobenzene, 1,4-dihydroxy-3-methylbenzene; and dihydroxydiphenyl sulfides and sulfoxides such as bis(4-hydroxyphenyl)sulfide, bis(4-hydroxy-phenyl)sulfoxide and bis(3,5-dibromo-4-hydroxyphenyl)sulfoxide. A variety of additional dihydric phenols are available and are disclosed in U. S. Patent Nos. 2,999,835, 3,028,365 and 3,153,008; all of which are incorporated herein by reference. It is possible to employ two or more different dihydric phenols or a combination of a dihydric phenol with a glycol.

The carbonate precursors are typically a carbonyl halide, a diarylcarbonate, or a bishaloformate. The carbonyl halides include, for example, carbonyl bromide, carbonyl chloride, and mixtures thereof. The bishaloformates include the bishaloformates of dihydric phenols such as bischloroformates of 2,2-bis(4-hydroxyphenyl)-propane, hydroquinone, and the like, or bishaloformates of glycol, and the like. While all of the above carbonate precursors are useful, carbonyl chloride, also known as phosgene, and diphenyl carbonate are preferred.

The aromatic polycarbonates can be manufactured by any processes such as by reacting a dihydric phenol with a carbonate precursor, such as phosgene, a haloformate or carbonate ester in melt or solution. U.S. Pat. No. 4,123,436 describes reaction with phosgene and U.S. Pat. No. 3,153,008 describes a transesterification process.

Preferred polycarbonate will be made of dihydric phenols that result in resins having low birefringence for example dihydric phenols having pendant aryl or cup shaped aryl groups like:

15            Phenyl-di(4-hydroxyphenyl) ethane (acetophenone bisphenol):  
               Diphenyl-di(4-hydroxyphenyl) methane (benzophenone bisphenol):  
               2,2-bis(3-phenyl-4-hydroxyphenyl) propane  
               2,2-bis-(3,5-diphenyl-4-hydroxyphenyl) propane;  
               bis-(2-phenyl-3-methyl-4-hydroxyphenyl) propane;  
 20            2,2'-bis(hydroxyphenyl)fluorene;  
               1,1-bis(5-phenyl-4-hydroxyphenyl)cyclohexane;  
               3,3'-diphenyl-4,4'-dihydroxy diphenyl ether;  
               2,2-bis(4-hydroxyphenyl)-4,4-diphenyl butane;  
               1,1-bis(4-hydroxyphenyl)-2-phenyl ethane;  
 25            2,2-bis(3-methyl-4-hydroxyphenyl)-1-phenyl propane ;  
               6,6'-dihydroxy-3,3,3',3'-tetramethyl-1,1'-spiro(bis)indane;  
               (hereinafter "SBI"), or dihydric phenols derived from spiro biindane of formula :



Units derived from SBI and its 5-methyl homologue is preferred, with SBI being most preferred.

Other dihydric phenols, which are typically used in the preparation of the polycarbonates, are disclosed in U.S. Patents Numbers 2,999,835, 3,038,365, 3,334,154 and 4,131,575. Branched polycarbonates are also useful, such as those described in U.S. Patent Numbers 3,635,895 and 4,001,184. Polycarbonate blends include blends of linear polycarbonate and branched polycarbonate.

It is also possible to employ two or more different dihydric phenols or a copolymer of a dihydric phenol with an aliphatic dicarboxylic acids like; dimer acids, dodecane dicarboxylic acid, adipic acid, azelaic acid in the event a carbonate copolymer or interpolymer rather than a homopolymer is desired for use in the preparation of the polycarbonate mixtures of the invention. Most preferred are aliphatic C<sub>5</sub> to C<sub>12</sub> diacid copolymers.

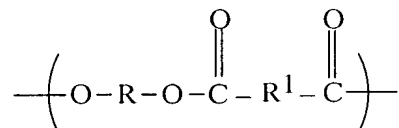
The preferred polycarbonates are preferably high molecular weight aromatic carbonate polymers have an intrinsic viscosity (as measured in methylene chloride at 25°C) ranging from about 0.30 to about 1.00 dl/gm. Polycarbonates may be branched or unbranched and generally will have a weight average molecular weight of from about 10,000 to about 200,000, preferably from about 20,000 to about 100,000 as measured by gel permeation chromatography. It is contemplated that the polycarbonate may have various known end groups.

The aromatic polycarbonates can be prepared in several ways: the most common being by the so-called interfacial process or the melt transesterification process. In the thermoplastic materials used for the manufacture of the crates of the invention all kind of aromatic polycarbonates can be used as long as the combination with the polyester remains transparent or translucent.

Suitable aromatic polycarbonates are sold commercially under the trademark Lexan.

## POLYESTER

The cycloaliphatic polyester resin comprises a polyester having repeating units of the formula:



5 where at least part of all R is a cycloalkyl containing radical and R<sup>1</sup> is a cycloalkyl or an aromatic radical.

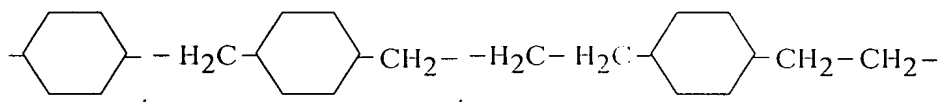
The polyester is a condensation product where R is the residue of an aryl, alkane or cycloalkane containing diol having 2 to 20 carbon atoms or chemical equivalent thereof. To ensure miscibility with the aromatic polycarbonate at least part of R should be derivable from  
10 a cycloalkane. R<sup>1</sup> is the decarboxylated residue derived from an aryl or cycloalkane containing diacid of 6 to 20 carbon atoms or chemical equivalent thereof.

The polyesters are condensation products of cycloaliphatic or aromatic diacids, or chemical equivalents and of at least some cycloaliphatic diols, or chemical equivalents. The present polyesters may be formed from mixtures of cycloaliphatic or aromatic diacids and  
15 cycloaliphatic diols. It is preferred that 50-100 mol %, or 50-90 mol % that of the diol component consists of cycloaliphatic diols and 0-50 mol % or 10-50 mol % of non-cyclic aliphatic diols. The cyclic components help to impart good rigidity to the polyester and to allow the formation of transparent blends due to favourable interaction with the polycarbonate resin.

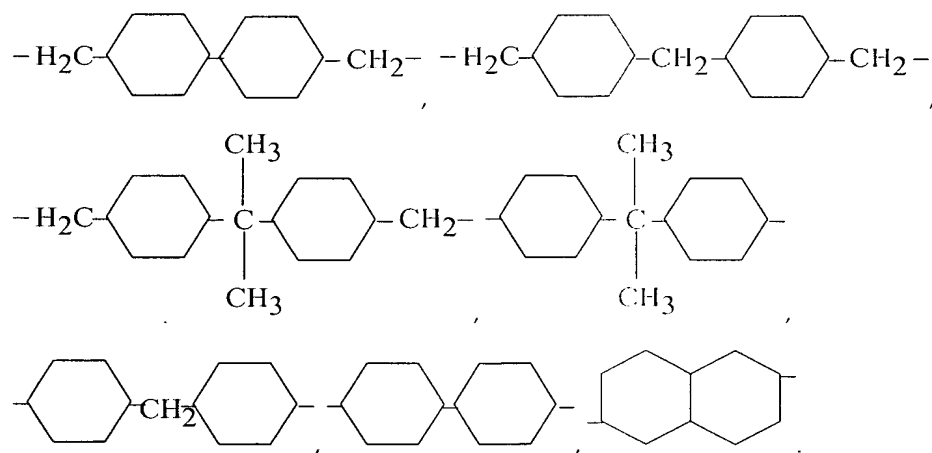
20 The polyester resins are typically obtained through the condensation or ester interchange polymerisation of the diol or diol equivalent component(s) with the diacid or diacid chemical equivalent component(s).

In the above formula R and R<sup>1</sup> can be one or more cycloalkyl radicals independently selected from the following formula:

25







The preferred cycloaliphatic radical R1 is derived from the 1,4-cyclohexyl. The preferred cycloaliphatic radical R is derived from the 1,4-cyclohexyl primary diols such as 1,4-cyclohexyl dimethanol.

5           The aromatic radical R1 can be derived from a phthalic acid like iso- or tere-phthalic acid.

Other diols useful in the preparation of the polyester resins of the present invention are straight chain, branched, or cycloaliphatic alkane diols and may contain from 2 to 16 carbon atoms. Examples of such diols include but are not limited to ethylene glycol; propylene glycol, i.e., 1,2- and 1,3-propylene glycol; 2,2-dimethyl-1,3-propane diol; 2-ethyl, 2-methyl, 1,3-propane diol; 1,3- and 1,5-pentane diol; dipropylene glycol; 2-methyl-1,5-pentane diol; 1,6-hexane diol; dimethanol decalin, dimethanol bicyclo octane; 1,4-cyclohexane dimethanol and particularly its cis- and trans-isomers; 2,2,4,4-tetramethyl-1,3-cyclobutanediol (TMCBD), triethylene glycol; 1,10-decane diol; and mixtures of any of the foregoing.

15   Preferably a cycloaliphatic diol or chemical equivalent thereof and particularly 1,4-cyclohexane dimethanol or its chemical equivalents are used as the diol component.

Chemical equivalents to the diols include esters, such as dialkylesters, diaryl esters and the like.

20           The diacids useful in the preparation of the aliphatic polyester resins of the present invention can be cycloaliphatic diacids or aromatic diacids. This is meant to include carboxylic acids having two carboxyl groups each of which is attached to a carbon. Preferred diacids are cyclo or bicyclo aliphatic acids, for example, decahydro naphthalene dicarboxylic

acids, norbornene dicarboxylic acids, bicyclo octane dicarboxylic acids, 1,4-cyclohexanedicarboxylic acid or chemical equivalents, and most preferred is trans-1,4-cyclohexanedicarboxylic acid or chemical equivalent. Suitable aromatic diacids are for example iso- or terephthalic acid or their chemical equivalent. Linear dicarboxylic acids like  
 5 adipic acid, azelaic acid, dicarboxyl dodecanoic acid and succinic acid can also be additionally incorporated in the polyester to replace up to 30 or up to 20 mol % of the cycloaliphatic or aromatic diacid.

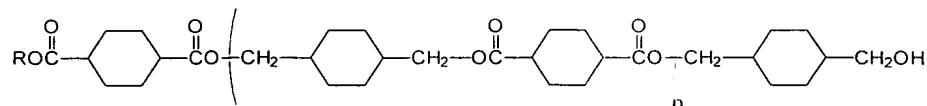
Cyclohexane dicarboxylic acids and their chemical equivalents can be prepared, for example, by the hydrogenation of cycloaromatic diacids and corresponding derivatives such  
 10 as isophthalic acid, terephthalic acid or naphthalenic acid in a suitable solvent such as water or acetic acid using a suitable catalysts such as rhodium supported on a carrier such as carbon or alumina. See, Friefelder et al., Journal of Organic Chemistry, 31, 3438 (1966); U.S. Pat. Nos. 2,675,390 and 4,754,064. They may also be prepared by the use of an inert liquid medium in which a phthalic acid is at least partially soluble under reaction conditions and with a catalyst  
 15 of palladium or ruthenium on carbon or silica. See, U.S. Pat. Nos. 2,888,484 and 3,444,237.

Typically, in the hydrogenation, two isomers are obtained in which the carboxylic acid groups are in cis- or trans-positions. The cis- and trans-isomers can be separated by crystallization with or without a solvent, for example, n-heptane, or by distillation. The cis-isomer tends to blend better; however, the trans-isomer has higher melting and crystallization  
 20 temperatures and may be preferred. Mixtures of the cis- and trans-isomers are useful herein as well.

When the mixture of isomers or more than one diacid or diol is used, a copolyester or a mixture of two polyesters may be used as the present cycloaliphatic polyester resin.

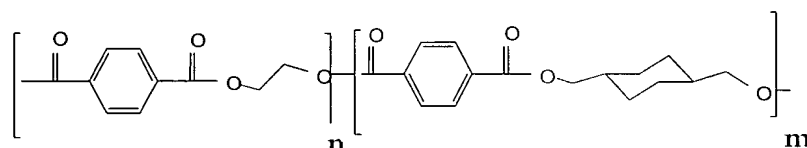
Chemical equivalents of these diacids include esters, alkyl esters, e.g., dialkyl esters,  
 25 diaryl esters, anhydrides, salts, acid chlorides, acid bromides, and the like. The preferred chemical equivalents comprise the dialkyl esters of the cycloaliphatic diacids, and the most favoured chemical equivalent comprises the dimethyl ester of the acid, particularly dimethyl-1,4-cyclohexane-dicarboxylate.

A preferred cycloaliphatic polyester is poly(cyclohexane-1,4-dimethylene  
 30 cyclohexane-1,4-dicarboxylate) also referred to as poly(1,4-cyclohexane-dimethanol-1,4-dicarboxylate) (PCCD), which has recurring units of formula :



With reference to the previously set forth general formula, for PCCD, R is derived from 1,4 cyclohexane dimethanol; and R1 is a cyclohexane ring derived from cyclohexanedicarboxylate or a chemical equivalent thereof. The favoured PCCD has a cis/trans formula.

- 5 Another preferred semi cycloaliphatic polyester is poly(cyclohexane-1,4-dimethylene terephthalate) (PCT) or PCT modified with ethyleneglycol (EG), which is known as PCTG, which has recurring units of formula:



- 10 There are two commercial PCTG types on the market which are suitable for this application; Eastar 5445 and Eastar 10179, the diol of Eastar 5445 contains 40 mol % EG and 60 mol % CHDM (cyclohexanedimethanol), while the Eastar 10179 contains around 20 mol % EG and 80 mol % CHDM. Both polyesters are miscible with PC and can be used for this application. The minimum amount of CHDM in the PCTG needs to be about 40 % to ensure good  
15 miscibility with PC ( $m/n > 40/60$ ).

The polyester polymerisation reaction is generally run in the melt in the presence of a suitable catalyst such as a tetracid (2-ethyl hexyl) titanate, in a suitable amount, typically about 50 to 200 pip of titanium based upon the final product.

- 20 The preferred aliphatic polyesters used in the present transparent moulding compositions have a glass transition temperature ( $T_g$ ) which is above 50°C, more preferably above 65 °C and most preferably above about 80 C.

- Also contemplated herein are the above polyesters with from about 1 to about 50 percent by weight, of units derived from polymeric aliphatic acids and/or polymeric aliphatic polyols to form copolyesters. The aliphatic polyols include glycols, such as  
25 poly(ethylene glycol) or poly(butylene glycol). Such polyesters can be made following the teachings of, for example, U.S. Pat. Nos. 2,465,319 and 3,047,539.

#### OTHER ADDITIVES

In the thermoplastic compositions, which contain a polyester resin and a polycarbonate resin, it is preferable to use a stabilizer or quencher material. Catalyst quenchers are agents, which inhibit activity of any catalysts, which may be present in the resins. Catalyst quenchers are described in detail in U.S. Patent 5,441,997. It is desirable to  
 5 select the correct quencher to avoid colour formation and loss of clarity to the polyester polycarbonate blend.

A preferred class of stabilizers/ quenchers is those, which provide a transparent and colorless product. Typically, such stabilizers are used at a level of 0.001-10 weight percent and preferably at a level of from 0.005-2 weight percent. The favored stabilizers include an  
 10 effective amount of an acidic phosphate salt; an acid, alkyl, aryl or mixed phosphate having at least one acidic hydrogen; a Group IB or Group IIB metal phosphate salt; a phosphorus oxo acid; a metal acid pyrophosphate or a mixture thereof. The suitability of a particular compound for use as a stabilizer and the determination of how much is to be used as a  
 15 stabilizer may be readily determined by preparing a mixture of the polyester resin component and the polycarbonate and determining the effect on melt viscosity, gas generation or color stability or the formation of interpolymer. The acidic phosphate salts include sodium dihydrogen phosphate, mono zinc phosphate, potassium hydrogen phosphate, calcium dihydrogen phosphate and the like.

The phosphate salts of a Group IB or Group IIB metal include zinc phosphate and the  
 20 like. The phosphorus oxo acids include phosphorous acid, phosphoric acid, polyphosphoric acid or hypophosphorous acid.

The metal acid pyrophosphates may be of the formula:



wherein M is a metal, x is a number ranging from 1 to 12 and y is a number ranging 1  
 25 to 12, n is a number from 2 to 10, z is a number from 1 to 5 and the sum of (xz) + y is equal to n + 2. The preferred M is an alkaline or alkaline earth metal.

The most preferred quenchers are oxo acids of phosphorus or acidic organo phosphorus compounds. Inorganic acidic phosphorus compounds may also be used as quenchers, however they may result in haze or loss of clarity. Most preferred quenchers are  
 30 phosphoric acid, phosphorous acid or their partial esters.

In one embodiment, the polycarbonate/polyester compositions may include less than about 20 percent, and preferably less than about 15 percent of an impact modifier ( measured

with respect of 100 pbw of PC + PE) . Typical impact modifiers generally comprise an acrylic or methacrylic grafted polymer of a conjugated diene or an acrylate elastomer, alone, or copolymerized with a vinyl aromatic compound. In general these impact modifiers contain units derived from butadiene or isoprene, alone or in combination with a vinyl aromatic compound, or butyl acrylate, alone or in combination with a vinyl aromatic compound.

Other typical impact modifiers include, but are not limited to ethylene vinyl acetate, ethylene ethylacrylate copolymers, SEBS (styrene-ethylene-butylene styrene) and SBS (styrene-butadiene-styrene) block copolymers, EPDM (ethylene propylene diene monomer) and EPR (ethylene propylene rubber) copolymers, etc

According to one embodiment, transparent and highly ductile compositions can be obtained via the blending of poly(cyclohexane dimethanol cyclohexane dicarboxylate) (PCCD), PC and a transparent impact modifier with a refractive index (RI) between 1.51 and 1.58. The complete miscibility of PC and PCCD allows adjustment of the RI of the PC/PCCD blend to the RI of the impact modifier. There are many impact modifiers that are suitable and some examples are given to illustrate. Examples of such impact modifiers are a clear ABS (acrylonitrile-butadiene-styrene, RI=1.535) and typical PVC modifiers like Blendex 415 / 336 (ABS material) supplied by GE Plastics or Paraloid BTA 702 / 736 (MBS material) supplied by Rohm & Haas or Kane Ace B28 / B58 (MBS material) supplied by Kaneka. All these PVC modifiers do have a RI between 1.53 and 1.55. These parts have a unique combination of impact, transparency and chemical resistance.

Additionally, additives such as mold releases, antioxidants lubricants, nucleating agents such as talc and the like, other stabilizers including but not limited to UV stabilizers, such as benzotriazole, supplemental reinforcing fillers, and the like, flame retardants, pigments or combinations thereof may be added to the compositions of the present invention.

It is possible to add visual effect additives like metal or mica flakes in combination with organic dyes that do not result in a significant increase in the brittle nature of the material. Attention should also be paid that the crates remain transparent or translucent. A colorant in the form of flakes can be present for imparting a desired coloration. Preferably the colorant flakes which ranging in size between 17.5 and 650 microns are used in loadings of 0.01 to 20.0 weight percent, preferably 0.10 to 15.0 weight percent, more preferably 0.25 to 10.0 weight percent, and most preferably 0.5 to 5.0 weight percent are preferred. The flakes are preferably metal flakes. The term metal flakes is intended to include thin particles including thin film, foil, or platelets which typically have a metallic appearance.[need to

refine dimension info] Preferred metal particles are based on metals of Group I-B, III-A, IV, VI-B and VIII of the periodic table. Also, physical mixtures or alloys of these metals may be employed. Also, physical mixtures or alloys of these metals may be employed. Examples of these metals include aluminum, bronze, brass, chromium, copper, gold, iron, molybdenum, nickel, tin, titanium, zinc and the like. For most applications, a "cornflake" type or corrugated irregularly shaped planar flake of aluminum or bronze is preferred, although a "silver dollar" type or a circular planar type of flake may also be utilized. Use of metal particles having two or more average flake sizes, i.e. at least two different average particle sizes, has been found to give much better control of the desired appearance and also been found to allow a greater consistency of achieving the desired appearance.

Aluminum flakes produce a satiny silver luster. In general, smaller particle sizes tend to have greater opacity and hiding power with a grayish effect, while larger flake sizes show greater brightness and reflectivity with increased metallic sparkle. Combinations of particle sizes are utilized to balance tinctorial strength and specular effects in addition to providing control of look and consistency.

Glitter is a special type of aluminium pigment produced from foil. The foil, rolled to gauges of less than 0.001 inch, is cut into square, rectangular or hexagonal shapes in sizes from 0.008 to 0.125 inch and typically coated with a transparent epoxy lacquer to halt oxidative dulling of the foil. Glitter, with its large particle sizes, can produce discrete specular highlights.

Gold bronzes are actually bronzes--alloys of copper and zinc with a small amount of aluminum to reduce oxidation. The range of gold colours is produced by varying proportions of major alloy components. The green golds contain 70 percent copper, and colour becomes redder as the percentage of copper is increased; 90 percent copper produces pale gold; deep golds are made by controlled oxidation of the alloys. Gold bronzes are usually utilized in flake form, with coarser grades giving more brilliance. Copper must be utilized with care, however, as it is susceptible to heat, moisture and corrosives.

Mould releases such as pentaerythritol tetra esters, especially the stearate esters. Also preferred are carboxylic acid esters of other polyols like glycerol; for example glycerol mono stearate.

Other additional ingredients may include antioxidants, and UV absorbers, and other stabilizers. Antioxidants include i) alkylated monophenols, for example: 2,6-di-tert-butyl-4-

methylphenol, 2-tert-butyl-4,6-dimethylphenol, 2,6-di-tert-butyl-4-ethylphenol, 2,6-di-tert-butyl-4-n-butylphenol, 2,6-di-tert-butyl-4-isobutylphenol, 2,6-dicyclopentyl-4-methylphenol, 2-(alpha-methylcyclohexyl)-4,6-dimethylphenol, 2,6-di-octadecyl-4-methylphenol, 2,4,6-tricyclohexylphenol, 2,6-di-tert-butyl-4-methoxymethylphenol; ii) alkylated hydroquinones, for example, 2,6-di-tert-butyl-4-methoxyphenol, 2,5-di-tert-butyl-hydroquinone, 2,5-di-tert-amyl-hydroquinone, 2,6-diphenyl-4-octadecyloxyphenol; iii) hydroxylated thiodiphenyl ethers; iv) alkylidene-bisphenols; v) benzyl compounds, for example, 1,3,5-tris-(3,5-di-tert-butyl-4-hydroxybenzyl)-2,4,6-trimethylbenzene; vi) acylaminophenols, for example, 4-hydroxy-lauric acid anilide; vii) esters of beta-(3,5-di-tert-butyl-4-hydroxyphenol)-propionic acid with monohydric or polyhydric alcohols; viii) esters of beta-(5-tert-butyl-4-hydroxy-3-methylphenyl)-propionic acid with monohydric or polyhydric alcohols; vii) esters of beta-(5-tert-butyl-4-hydroxy-3-methylphenyl) propionic acid with mono-or polyhydric alcohols, e.g., with methanol, diethylene glycol, octadecanol, triethylene glycol, 1,6-hexanediol, pentaerythritol, neopentyl glycol, tris(hydroxyethyl) isocyanurate, thiodiethylene glycol, N,N-bis(hydroxyethyl) oxalic acid diamide. Typical, UV absorbers and light stabilizers include i) 2-(2'-hydroxyphenyl)-benzotriazoles, for example, the 5'-methyl-,3',5'-di-tert-butyl-,5'-tert-butyl-,5'-(1,1,3,3-tetramethylbutyl)-,5-chloro-3',5'-di-tert-butyl-,5-chloro-3'-tert-butyl-,5'-methyl-,3'-sec-butyl-5'-tert-butyl-,4'-octoxy,3',5'-ditert-amyl-3',5'-bis-(alpha, alpha-dimethylbenzyl)-derivatives; ii) 2,2'-Hydroxy-benzophenones, for example, the 4-hydroxy-4-methoxy-,4'-octoxy-,4'-decyloxy-,4'-dodecyloxy-,4'-benzyloxy-,4,2',4'-trihydroxy-and 2'-hydroxy-4,4'-dimethoxy derivative, and iii) esters of substituted and unsubstituted benzoic acids for example, phenyl salicylate, 4-tert-butylphenyl-salicylate, octylphenyl salicylate, dibenzoylresorcinol, bis-(4-tert-butylbenzoyl)-resorcinol, benzoylresorcinol, 2,4-di-tert-butylphenyl-3,5-di-tert-butyl-4-hydroxybenzoate and hexadecyl-3,5-di-tert-butyl-4-hydroxybenzoate. Phosphites and phosphonites stabilizers, for example, include triphenyl phosphite, diphenylalkyl phosphites, phenyldialkyl phosphites, tris(nonyl-phenyl)phosphite, trilauryl phosphite, trioctadecyl phosphite, distearyl pentaerythritol diphosphite, tris(2,4-di-tert-butylphenyl)phosphite, diisodecyl pentaerythritol diphosphite, bis(2,4-di-tert-butylphenyl)pentaerythritol diphosphite tristearyl sorbitol triphosphite, and tetrakis(2,4-di-tert-butylphenyl)4,4'-biphenylene diphosphonite.

The preferred dyes or pigments, if desired, are organic dyes or pigment complexes which are, in themselves, soluble in the resin matrix. These organic dyes and pigments include the following classes and examples: furnace carbon black, phthalocyanine blues or greens, anthraquinone dyes, scarlet 3B Lake, azo compounds and acid azo pigments, quinacridones, chromophthalocyanine pyrroles, halogenated phthalocyanines, quinolines,

heterocyclic dyes, perinone dyes, anthracenedione dyes, thioxanthene dyes, parazolone dyes, polymethine pigments and others. It may be necessary to use small quantities of inorganic pigments such as TiO<sub>2</sub>, iron oxide, cadmium–mercury compounds, cadmium–lithium compounds, etc. to achieve certain colours, but such inorganic pigments are generally not used.

For some kind of beverages it is of importance that the container for the beverage absorbs UV radiation. To this end beer bottles are often made out of brown glass, which absorbs UV radiation and part of the visible light up to the 460 nm. The most harmful radiation is in the UV range up to about 410 nanometer, though radiation up to about 460 nanometer also has a negative effect on the quality of beer. It is possible to protect the beverages further by the usage of crates that also absorb UV radiation. This can be achieved by using for the manufacture of the crates materials provided with dyes that absorb UV light. This restricts however the available colours for the crates. By admixing a yellow dye absorbing the detrimental UV radiation with one or more other dyes it is often possible to get any desired colour in combination with the desired UV absorption. Alternatively it is possible to use in the material for the crates one or more dyes giving the desired color in combination with UV absorbers.

By choosing the proper wall thickness, the proper combination of dyes or by using suitable UV absorbers or by any combination of the foregoing, it is possible to obtain a crate with sidewalls that do not transmit more than 10 % or even not more than 5 % of the incident radiation with a wavelength of 200 to 460 nanometer upon perpendicular incidence of the UV radiation. The measurement should be made on a representative spot of the surface of the side walls.

The method of blending the compositions can be carried out by conventional techniques. One convenient method comprises blending the polyester or polycarbonate and other ingredients in powder or granular form, extruding the blend and comminuting into pellets or other suitable shapes. The ingredients are combined in any usual manner, e.g., by dry mixing or by mixing in the melted state in an extruder, on a heated mill or in other mixers. Colorants may be added to the extruder downstream of the feed port.

The flakes are incorporated into the resin composition by uniformly mixing into the desired resin composition. It is important flakes be stable at processing temperatures. Stability is desired at temperatures on the order of about 200, preferably at 260, and even more preferably 290 degrees C. Unstable flakes should be avoided.



The compositions of the present invention include dyes and stabilizers that are added in effective amounts to impart the desired properties on the compositions of the present invention for the specific application.

5 The resin comprises less than 5 percent by weight additional ingredients which may be added to contribute to desirable properties previously mentioned of additional, important properties which include good mechanical properties, color stability, oxidation resistance, good flame retardancy, good processability, i.e. short molding cycle times, good flow, and good insulation properties.

10 One convenient method comprises blending the resins and other ingredients in powder or granular form, extruding the blend and comminuting into pellets or other suitable shapes. The ingredients are combined in any usual manner, e.g., by dry mixing or by mixing in the melted state in an extruder, on a heated mill or in other mixers. An alternative method of blending can comprise preparing a preblend of the polyesters and then adding the other ingredients to the preblend. For example, a preblend of the resins and stabilizer can be fed  
15 into the upstream port of an extruder with addition of the other ingredients such as glass fibers in a downstream port of the extruder. In another embodiment, the various compounds can be precompounded, pelletized and then molded. Precompounding can be carried out in conventional equipment. For example, a dry blend of the ingredients can be fed into a single screw extruder, the screw having a long transition section to insure proper melting.  
20 Alternatively, a twin screw extrusion machine can be fed with the resins and other additives at the feed port and reinforcements fed downstream. In either case, a generally suitable machine temperature will be from about 230 to about 300 °C. The precompounded composition can be extruded and cut or chopped into molding compounds, such as conventional granules, pellets, etc. by standard techniques. The compositions can be molded  
25 in any equipment conventionally used for thermoplastic compositions. For example, good results will be obtained in an injection molding machine, with conventional cylinder temperatures, e.g., 260°C, and conventional mold temperatures, e.g., 65 °C.

It is however of importance that the exact composition of the polycarbonate and the polyester is chosen such that the blend of the polyester(s) with the aromatic polycarbonate(s)  
30 remains transparent or translucent. Such blends are generally known and have been described in the patent literature. Reference can be made for example to US 4,786,692 and US 4,188,314.

In one embodiment of the invention the nature of the polyester and the polycarbonate and the relative quantity of the polyester and the thickness of the side walls are chosen such that the side walls of the crate made out of the blend have at their most transparent spot a transmittance for visible light upon perpendicular incidence of more than 50%. Optical properties (transmission and haze) were measured according ASTM D1003; the yellowness index (according ASTM D1925) of 2.5 mm thick plaques was measured on a Gardner XL-835 Colorimeter.

#### Examples

The following examples serve to illustrate the invention but are not intended to limit the scope of the invention. Blends were prepared by tumbling all ingredients together for 1-5 min at room temperature followed by extrusion at 250-300 °C on a co-rotating 30 mm vacuum vented twin screw extruder. Blends were run at 300 rpm. The output was cooled as a strand in a water bath and pelletized.

The obtained extrudate was pelletised. The obtained pellets were dried at 100-120 °C for 3-6 h and injection moulded into a standard model of a crate for eight half litre beer bottles or into plaques of 7.5 by 5.7 cm, and 2.5 mm thickness for determining optical properties and into test bars for determining the chemical resistance.

#### Used components:

##### - Materials used

Material	Trade name / Source	Property
Polycarbonate 1	Lexan / GE Plastics	IV = 58-59 ml/g
Polycarbonate 2	Lexan / GE Plastics	IV = 46-48 ml/g
Polycarbonate 3	Lexan / GE Plastics	IV = 48-50 ml/g
Polycarbonate 4	Lexan / GE Plastics	IV = 52-54 ml/g
Poly(cyclohexane dimethanol terephthalate), ethyleneglycol modified *	PCTG / Eastman	Mw = 60000 (expressed as PS-data)
Pentaerythritol tetrastearate	PETS / Loxiol / Henkel	Release agent
Mixture of phosphonous acid esters a.o. Tetrakis(2,4-di-t-butylphenyl-4,4'-biphenylene-diphosphonite)	PEPQ / Ciba	Heat stabilizer
H <sub>3</sub> PO <sub>3</sub> (45% aqueous solution)	Phosphorous acid / Caldic	Catalyst quencher
U1: 2(2-hydroxy-5-t-octylphenyl) benzotriazole	Cyasorb UV5411 / Cytec	UV-stabilizer
U1: 2(2-hydroxy-3'-t-butyl-5'-methylphenyl-5-chloro- benzotriazole	Tinuvin 326 / Ciba	UV-stabilizer
CB: carbon black	Carbon Black / Cabot	Colorant
P7: Copper Chlorophthalocyanine	Heliogen Green K8730 Basf	Colorant
P36: Copper Chlorobromophthalocyanine	Heliogen Green K9360/ Basf	Colorant
S35: 8,9,10,11-tetrachloro-12H-phtaloperin-12-one	Macrolex Red EG / Bayer	Colorant
PB: Copper Phtalocyanine	Heliogen Blue / Basf	Colorant
S93: Substituted Pyrazolone	Macrolex Yellow / Bayer	Colorant

IV = intrinsic viscosity

\* = PCTG: a polyester with units derivable from terephthalic acid, cyclohexane dimethanol (CHDM) and ethylene glycol (EG) with a ratio of CHDM to EG of 80:20.

5 The formulations as shown in Table 1 have been prepared. All quantities have been indicated in % by weight.

Table 1

Formulation no	1	2a	2b	3	4	5	6	7	8	9	10
PE	20	20	40	20	20	20	20	20	20	20	20
PC 1	64.3	64.3	44.3	59.6	64.9	64.9	65.0	64.9	64.9	64.7	64.7
PC 2	15	15	15	20	14	14	14	14	14	14	14
PC 3	-	-	-	-	-	-	-	-	-	-	-
PC 4	-	-	-	-	-	-	-	-	-	-	-
PETS	0.3	0.3	0.3	-	0.3	0.3	0.3	0.3	0.3	0.3	0.3
PEPQ	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
U 1	0.25	0.25	0.25	0.25	-	0.25	0.25	0.25	-	-	0.25
U 2	-	-	-	-	0.3	0.3	-	-	0.3	0.5	0.3
H3PO3	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
CB	-	-	-	0.003	0.001	0.001	0.001	0.001	0.003	0.003	0.003
PB	-	-	-	-	0.012	0.012	0.012	0.012	-	-	-
P7	-	-	-	0.01	-	-	-	-	0.01	0.01	0.01
P36	-	-	-	0.013	-	-	-	-	0.013	0.013	0.013
S 93	-	-	-	-	0.02	0.05	0.02	0.05	-	-	-
S 135	-	-	-	0.0003	-	-	-	-	0.0003	0.0003	0.0003

The following properties have been evaluated.

Drop test: the injection moulded beer crate was dropped from a height of 3.5 metres before  
 5 and after being immersed for 1 hour in a 1% NaOH solution held at 70 °C. The crate was  
 visually inspected for crack forming. NO: means no cracks observed.

Chemical resistance: the test bars were under a constant strain (in a jig) immersed in a 1%  
 10 NaOH solution at 65° C. The time (in minutes) to crack formation was measured.

Light absorption: Light transmission was measured with 2.5 mm and was found to be > 85 %  
 for all samples in Table 1.

The results for the drop test are given in Table 2. The results for the light absorption are  
 15 represented in Figures 2 and 3.

Table 2

Formulation no	1	Pure PC 3	Pure PC 4	2a	2b
Drop test					
-before immersion	NO	-	-	-	-
-after immersion*	NO	-	-	-	-
Chemical resistance (in minutes)					
Strain 0.70 %	-	4	3	23	36
Strain 1 %	-	3	6	17	34

20 \* Crate was still transparent

Discussion of results.

The results of Table 2 show that the material is suitable for making crates. It withstands a fall  
 25 from sufficient height and it has sufficient chemical resistance.

The material of formulation no 2 meets all standard requirements for making a crate.  
 However as shown in figure 2 it does not absorb UV radiation to a sufficient extent. The

pigments give the crate a green transparent color. Obviously any other color can be obtained by the right selection of pigments.

Formulations 5 and 7 have also a nice deep greenish colour just as formulations 4 and 6. Their absorption is far superior to the absorption of formulation 2, as can be seen from figure 3.